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INVESTIGATION TO ELIMINATE THE NEGATIVE EFFECT OF DUST-SUPPRESSING SURFACTANTS ON FLOTATION (KIDD CREEK ORE)

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INVESTIGATION TO ELIMINATE THE NEGATIVE EFFECT OF DUST-SUPPRESSING
SURFACTANTS ON FLOTATION (KIDD CREEK ORE)

by

M.A. Cristovici* and D.R. McCarthy**

ABSTRACT

Laboratory experiments indicated that a solution of surfactants sprayed on ore to suppress dust had a negative influence on the subsequent flotation process. A technique to remove the surfactant prior to flotation which had been previously developed for the flotation of a single mineral has been successfully verified and modified for multi-mineral selective flotation.

Adsorption of surfactants on activated carbon and removal of the loaded carbon prior to flotation has restored the flotability of the ore contaminated with wetting agents.

Field trials are now required to evaluate the efficiency of this technology and its impact on the cost of mining and processing various ores.

Keywords: surfactants, flotation, activated carbon, mine dust

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**ÉTUDE EN VUE D'ÉLIMINER LES EFFETS NÉGATIFS DES SURFACTANTS
UTILISÉS POUR SUPPRIMER LA POUSSIÈRE PENDANT LA FLOTTATION
(MINÉRAIS DE KIDD CREEK)**

par

M.A. Cristovici* et D.R. McCarthy**

RÉSUMÉ

Des expériences en laboratoire indiquent que la solution de surfactants que l'on vaporise sur le minerai pour supprimer la poussière a un effet négatif sur le procédé de flottation subséquent. Une technique développée antérieurement en vue de supprimer la poussière avant la flottation d'un seul minerai a été vérifiée et modifiée pour la flottation sélective de plusieurs minerais.

L'adsorption des surfactants sur du carbone activé et l'élimination du carbone chargé avant la flottation a rétablit la flottabilité du minerai contaminé par des agents mouillants.

Des essais sur le terrain sont maintenant requis pour évaluer l'efficacité de cette technologie et son impact sur les frais d'exploitation et de traitement de divers minerais.

Mots-clé : surfactants; flottation; carbone activé; poussière dans l'environnement minier.

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CONTENTS

	<u>Page</u>
ABSTRACT	i
INTRODUCTION	1
Objectives of the Investigation	1
Summary of Results	1
CONCLUSIONS AND RECOMMENDATIONS	3
DETAILED DESCRIPTION OF THE TESTWORK	4
Ore Sample	4
Wetting Agents Used as Dust Suppressors	5
Effect of Wetting Agents on Flotation Results	9
Investigation to Annihilate the Surfactants Negative Effect	10
REFERENCES	13
APPENDIX 1 - COST ESTIMATE PREPARED BY O.T.T.	15

TABLES

<u>No.</u>		
1.	Summary of flotation results	2
2.	Sample head assay	5
3.	Wetting agents tested as dust suppressors	5
4.	Summary of test results evaluating surfactants properties	8
5.	Flotation results with and without surfactant	10
6.	Flotation results after surfactant removal	12

FIGURES

1.	Scheme of surfactant removal technique	14
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INTRODUCTION

Surfactants received from various manufacturers of chemicals were investigated for their properties and ability to suppress sulphide ore dust.

Some wetting agents were selected as potential dust suppressors, but it was found that they interfered with the flotation process, deteriorating the grade of the concentrates and destroying the selectivity of mineral separation (1).

Research work has succeeded in developing a technique which would eliminate the surfactants' detrimental effect on flotation. The technique consists of adsorbing the wetting agents on activated carbon and removing the loaded carbon prior to flotation. The surfactant removal technology was thoroughly investigated and tuned for the case of a low sulphide content ore and single mineral flotation (2).

The next obvious step was to extend the application of the technique to a complex ore of high sulphide-polymineral composition and differential flotation. The case chosen for this work was the copper-zinc-pyrite Kidd Creek ore.

The present report deals with the experiments carried out to select dust suppressors for Kidd Creek ore and to eliminate surfactants' negative effect on flotation of this ore by using the carbon adsorption technique.

OBJECTIVES OF THE INVESTIGATION

The objectives of the investigation were:

1. Select optimum dust suppressing surfactants.
2. Verify and adjust the surfactant removal technique for a complex polymineral ore.
3. Estimate the cost of dust suppression using surfactants and the removal of the wetting agents by the carbon adsorption technique.

SUMMARY OF RESULTS

A sample of Cu-Zn-pyrite ore from Kidd Creek mine was used to test the carbon adsorption technique for surfactant-dust suppressor removal. The

ore sample assayed: 3.40% Cu, 5.68% Zn and 11.61% S. The surfactant adsorption technique was tested under flotation conditions similar to those applied in the plant, i.e., grinding the ore to approximately 60% -38 μ m and selective Cu-Zn flotation.

The reagent selected as a dust suppressor was a non-ionic surfactant manufactured by Alchem Inc. under the trade name Dust Ban 8A04. To prove the efficiency of the method to eliminate the wetting agents detrimental effect, an excessive amount of surfactant was used to simulate dust suppression, i.e., 50 L/t of ore (solution 2%), although standard spraying to combat dust requires only 10 L/t of ore.

The technique to remove the surfactant (Fig. 1) consisted of contacting the slurry after grinding with a specific brand of activated carbon for a certain period of time. During this conditioning stage, performed at low rpm, the surfactant was adsorbed on the activated carbon. The loaded carbon was then removed from the slurry by screening, leaving behind, for the subsequent flotation process, a surfactant-free pulp. A brand of activated carbon (SGL 8X30) produced from bituminous coal and marketed by Calgon Corporation proved to be adequate for this application.

The flotation results of surfactant contaminated ore with and without removal of the wetting agents are compared with the results of floating non-contaminated ore in Table 1.

Table 1 - Summary of flotation results

Condition	Assay %				% Distribution			
	Cu Conc.		Zn Conc.		Cu Conc.		Zn Conc.	
	Cu	Zn	Cu	Zn	Cu	Zn	Cu	Zn
No surfact. add.	19.02	7.61	0.25	47.20	94.9	23.3	0.6	66.6
Surfact. add.	12.32	9.00	0.48	48.20	84.6	30.6	1.0	50.5
Surfact. removed	20.20	7.70	0.45	43.65	94.3	22.6	1.1	68.0

Surfactant presence had a negative effect on Cu-Zn separation. The Cu grade and recovery in the copper concentrate has drastically dropped. Zinc in the copper concentrate has increased and Zn recovery in the zinc concentrate decreased.

By applying the surfactant removal technique the Cu grade and recovery in the copper concentrate has been restored and the zinc content reduced. The lower Zn content of the zinc concentrate was compensated by a higher recovery.

The carbon loss was less than 1 kg/tonne of ore. It is estimated that in a continuous process, carbon loss will be in the order of 0.2 kg/tonne of ore.

A cost estimate was prepared by CANMET's Office of Technology Transfer to approximate the required capital and operating expenses for implementing the technology of dust suppression and surfactants removal.

A 5000 t/d mill operation was arbitrarily chosen for this cost exercise. The estimated installed fixed capital cost was \$2,000,000.00 and the operating expenses were evaluated at \$1.42 per tonne of processed ore. Reagent cost, which represented 70% of the operating expenses, will govern the application of this technology.

Field trials will indicate the required concentration and amount of surfactant for dust suppression in any particular mine operation. Also, pilot plant runs will allow a better evaluation of carbon consumption in the process of surfactant removal. After that a more accurate cost estimate can be prepared to determine the viability of this technique.

CONCLUSIONS AND RECOMMENDATIONS

The following conclusions can be drawn from the results of the research work carried out to eliminate the negative effect of surfactants on complex ore flotation:

1. The surfactants used as dust suppressors on a complex Cu-Zn-pyrite ore proved to have a detrimental influence on the subsequent differential flotation of this ore.
2. The technology to eliminate the surfactants' negative effect, previously developed for flotation of a single mineral can be adjusted to deal with surfactant removal for a polymineral differential flotation.

3. The technology of surfactant removal consists of adsorbing the wetting agents on activated carbon and separating the carbon from the slurry prior to flotation.
4. By applying the carbon adsorption technique for surfactant removal, the detrimental flotation results were eliminated. The required carbon addition under excessive surfactant spraying was 60 kg/tonne of ore for a contact time of 15 minutes. The carbon loss was less than 1 kg/tonne of ore.
5. The operating cost of the technology to remove surfactants was evaluated at about \$1.42/tonne of which 70% is represented by reagent usage. It is obvious that a reduction in the amount of surfactant sprayed on the ore will significantly affect the cost of technology to combat dust and to eliminate the negative effect of surfactants.

The laboratory research work dealing with surfactant selection as dust suppressors and the elimination of the surfactant's negative effect on flotation has been completed. The next step in the program is to start underground experiments to determine the optimum conditions for dust suppression using surfactants.

Continuation of the research work to combat dust by systematic underground experiments is strongly recommended.

DETAILED DESCRIPTION OF THE TESTWORK

The surfactant removal technique previously developed for single mineral flotation has been verified and adjusted on a polymineral ore requiring selective flotation. Detailed results of this investigation follow.

ORE SAMPLE

A sample of Kidd Creek, Cu-Zn-pyrite ore was used to investigate surfactant removal by the carbon adsorption technique.

The chemical assay of the head sample is given in Table 2.

Table 2 - Sample head assay

Element	%
Cu	3.40
Pb	0.13
Zn	5.68
S	11.61

WETTING AGENTS USED AS DUST SUPPRESSORS

A number of wetting agents received from various manufacturers were tested for their properties to act as dust suppressors. These reagents are indicated in Table 3.

Table 3 - Wetting agents tested as dust suppressors

Reagent	Manufacturer	Chemical nomenclature	Surfactant type
X2-8603 193 E-5753-11-1 E-5753-11-2 E-5753-11-3 E-5753-11-5	Dow Corning	Aminofunctional silicon emulsion Silicone glycol copolymers Silicone glycol copolymers Silicone glycol copolymers Silicone glycol copolymers Silicone glycol copolymers	Cationic Non-ionic Non-ionic Non-ionic Non-ionic Non-ionic
Antarox BL-214 Antarox BL-225 Antarox BL-330	G.A.F.	Modified linear aliphatic polyethers Modified linear aliphatic polyethers Modified linear aliphatic polyethers	Non-ionic Non-ionic Non-ionic
8A07 8A04 8A08 8820	Alchem Inc.	Polyelectrolite-chloride Surfactant Latex polyelectrolite Acrylic, ethylene glycol, dioctyl sulfosuccinate mixture	Anionic Non-ionic Non-ionic Non-ionic

More detailed information about the physico-chemical characteristics of these surfactants, their present application and material safety data are available for examination on section files.

These wetting agents were subjected to a number of tests to determine their ability to perform as sulphide ore dust suppressors.

Selection of the most suitable wetting agents for this application was based on the following laboratory determinations:

1. Wetting ability, evaluated on the basis of the ore dust sinkage rate, expressed in mg/s and determined as the required time in seconds, for wetting and sinking a quantity of 1000 mg sulphide ore dust, spread on the surface of the reagent solution.
2. Foam volume and persistency evaluated by measuring the maximum volume of foam produced by the surfactants under certain conditions and the foam volume variation at successive time intervals.
3. Solubility of the surfactants determined at ambient temperature under various concentrations.

Also, in selecting the optimum wetting agents, consideration was given to safety data information supplied by the manufacturers in terms of health hazard and fire or explosion risk that could result by handling and operating the surfactants.

The procedures used to evaluate the surfactants properties were described in the 1983 study (1).

Detailed information on all the experiments conditions and results carried out to evaluate and select the surfactants are kept available for examination on section files.

The results of the testwork carried out to evaluate the wetting agents as potential sulphide ore dust suppressors are summarized in Table 4.

An overall selection was made on the basis of surfactants response to various testing conditions. The required mark to pass a test was in most of the cases arbitrarily chosen, dictated by the performances of the majority of the reagents with the intention to eliminate those that gave the most inferior results.

The most decisive criterion in selecting the surfactants was their ability to perform as wetting agents for sulphide ore dust, a property that was evidenced by their sinkage rate. However, those reagents which exhibited excessive foaming properties, showed very little solubility in water or

required special precautions in handling and operation were eliminated in the final selection regardless of their wetting ability.

One wetting agent was chosen from each group of surfactants supplied by Dow Corning, G.A.F. and Alchem. These surfactants should be used in field trials to determine the most effective dust suppression for any particular ore. However, for this study, to reduce the number of experiments, further laboratory work to verify the surfactants removal technique was carried out with Alchem reagent only.

Table 4 - Summary of test results evaluating surfactants properties

Surfactant	Sinkage			Foaming				Solubility			Safety		Overall selection
	Surf. Conc. %	Rate mg/s	Selection	Surf. Conc. %	Max. foam volume*	Foam persistency**	Selection	Surf. Conc. %	Sol'n clarity	Selection	Special precautions	Selection	
X2-8063 193 E-5753-11-1 E-5753-11-2 E-5753-11-3 E-5753-11-5	0.1	<4	No	2.0	2.75	0.24	Yes	2.0	cloudy	No	Unknown	No	Rejected
	0.1	50	No	2.0	3.75	0.49	No	2.0	clear	Yes	Unknown	No	Rejected
	0.1	1000	Yes	2.0	1.10	0.86	Yes	2.0	cloudy	No	Unknown	No	Accepted
	0.1	1000	Yes	2.0	2.50	0.52	Yes	2.0	cloudy	No	Unknown	No	Rejected
	0.1	1000	Yes	2.0	>5.00	0.30	No	2.0	cloudy	No	Unknown	No	Rejected
	0.1	500	Yes	2.0	0.75	0.92	No	2.0	cloudy	No	Unknown	No	Rejected
BL-214 BL-225 BL-330	0.1	1000	Yes	2.0	0.15	0.50	Yes	2.0	clear	Yes	None	Yes	Accepted
	0.1	1000	Yes	2.0	2.00	0.08	Yes	2.0	cloudy	No	None	Yes	Rejected
	0.1	1000	Yes	2.0	1.50	0.30	Yes	2.0	clear	Yes	Avoid vapours	No	Rejected
8A04 8A07 8A08 8820	0.1	500	Yes	2.0	3.00	0.69	Yes	2.0	clear	Yes	None	Yes	Accepted
	0.1	500	Yes	2.0	>5.00	1.00	No	2.0	clear	Yes	Avoid vapours	No	Rejected
	0.1	<2	No	2.0					cloudy	No	None	Yes	Rejected
	0.1	5	No	2.0	1.75	0.29	Yes	2.0	cloudy	No	Avoid vapours	No	Rejected

*Ratio between froth maximum volume and volume of solution

**Ratio between froth volumes at 30 minutes and at 1 minute

EFFECT OF WETTING AGENTS ON FLOTATION RESULTS

A sample of Kidd Creek copper-zinc-pyrite ore was used to examine, in laboratory scale, the influence of dust-suppressing surfactant Alchem 8A04 on flotation results.

To simulate the exposure of the ore to the wetting agent used as dust suppressor, the surfactant was added to the dry sample prior to the grinding stage. Solution of 2% wetting agent was used in the amount of 50 L per tonne of ore. About 10 L/t is considered an adequate spray to suppress the dust in an underground mine. However, to test the methods of dust suppression and surfactant removal under the most severe conditions, an excessive amount of wetting agent solution was employed.

After grinding, the slurry containing surfactants was transferred to a flotation cell and the selective copper-zinc flotation was carried out under conditions similar to those performed in the plant. The flotation results with and without surfactant addition were then compared.

To simplify the testwork the copper and zinc extraction was limited to open circuit rougher-scavenger flotation, the rougher concentrates representing the final products for each circuit.

The grinding and the reagents used in this testwork were similar to those employed in Kidd Creek concentrator.

The following conditions were used for the laboratory testwork:

Grinding	approx. 85% -74 μ m
Reagents	
Sulphurous acid (H_2SO_3), g/t	360
Lime, g/t	200
Cu-Flotation	
pH	7.5-8.0
Reagents	
Xanthate (Na-isobutyl), g/t	5
Aerofloat 208, g/t	45
Methylisobutylcarbinol (MIBC), g/t	50
Time (total flotation), min.	6

Zn-Flotation

pH	11.6
Reagents	
Lime, kg/t	3.2
Xanthate (Na-isobutyl), g/t	30
Methylisobutylcarbinol (MIBC), g/t	80
Time (total flotation), min.	4

The results of Cu-Zn flotation with and without surfactant addition are given in Table 5.

Table 5 - Flotation results with and without surfactant

Surfactant solution L/t	Product	% Weight	Assay %		% Distribution	
			Cu	Zn	Cu	Zn
Nil	Cu Rougher Conc.	17.4	19.02	7.61	94.9	23.3
	Cu Scaveng. Conc.	3.0	2.84	14.21	2.4	7.5
	Zn Rougher Conc.	8.0	0.25	47.20	0.6	66.6
	Zn Scaveng. Conc.	2.2	0.56	2.95	0.3	1.4
	Tailing	69.4	0.09	0.10	1.8	1.2
	Head (calc.)	100.0	3.40	5.68	100.0	100.0
50	Cu Rougher Conc.	19.8	12.32	9.00	84.6	30.6
	Cu Scaveng. Conc.	6.5	5.34	12.09	12.0	13.4
	Zn Rougher Conc.	6.1	0.48	48.20	1.0	50.5
	Zn Scaveng. Conc.	1.8	0.91	10.72	0.6	3.3
	Tailing	65.8	0.08	0.19	1.8	2.2
	Head (calc.)	100.0	2.88	5.82	100.0	100.0

The surfactant has negatively affected the Cu-Zn differential flotation. In the copper concentrate the Cu content and recovery has drastically decreased while the Zn losses became very high. Zinc recovery in the Zn concentrate has also dropped significantly.

INVESTIGATION TO ANNIHILATE THE SURFACTANTS NEGATIVE EFFECT

Research work to find a method for eliminating the surfactant negative effect on flotation was previously reported (2). The method, consisted in the adsorption of surfactants on activated carbon prior to

flotation. This technique was developed for a low sulphide ore with only one mineral to recover.

Additional testwork was required to expand the method applicability to complex ore, of higher sulphides content and polymineral composition. The following are the results of the work carried out on Kidd Creek copper-zinc-pyrite ore using dust-suppressing agent Alchem 8A04.

The technique of surfactants removal was applied under conditions similar to those used for low sulphide-single mineral flotation. Some variation in the amount of carbon addition was tried.

The surfactant removal procedure consisted of the following steps:

1. The Kidd Creek ore was sprayed with 2% solution of surfactant Alchem 8A04, in the amount of 50 L/t, to simulate an excessive exposure of the mined ore to dust suppression.
2. The surfactant-contaminated ore was placed in a grinding mill and the grinding was performed under usual conditions.
3. The ground ore was transferred to a conditioner and the activated carbon (Calgon SGL 8X30) was added in the amount of 1 to 100 kg/tonne of ore. The contact time between carbon and slurry was maintained for 15 minutes, under low rpm to reduce carbon degradation.
4. After conditioning, the surfactant-loaded carbon was removed by screening on a 425 μm screen. The ground ore was much finer than the carbon and it passed through the screen while the carbon sized +600 μm was retained on the 425 μm screen.
5. The surfactant-decontaminated slurry was transferred to a flotation cell, the flotation reagents were added and the Cu-Zn selective flotation was performed as usual.

By applying the carbon adsorption technique the detrimental influence of surfactants on flotation results has been eliminated. Table 6 gives the metallurgical results obtained on Kidd Creek ore after surfactant removal. The Cu content and recovery in the copper concentrate were similar to those obtained when no surfactant was added to the ore. Also, zinc

recovery in the Zn concentrate increased regaining the metal lost in the copper products.

Table 6 - Flotation results after surfactant removal

Products	% Weight	Assay %		% Distribution	
		Cu	Zn	Cu	Zn
Cu Rougher Conc.	16.0	20.20	7.70	94.3	22.6
Cu Scaveng. Conc.	2.0	3.40	16.92	2.0	6.2
Zn Rougher Conc.	8.5	0.45	43.65	1.1	68.0
Zn Scaveng. Conc.	1.6	1.09	4.00	0.5	1.2
Tailing	71.9	0.10	0.15	2.1	2.0
Head (calc.)	100.0	3.42	5.45	100.0	100.0

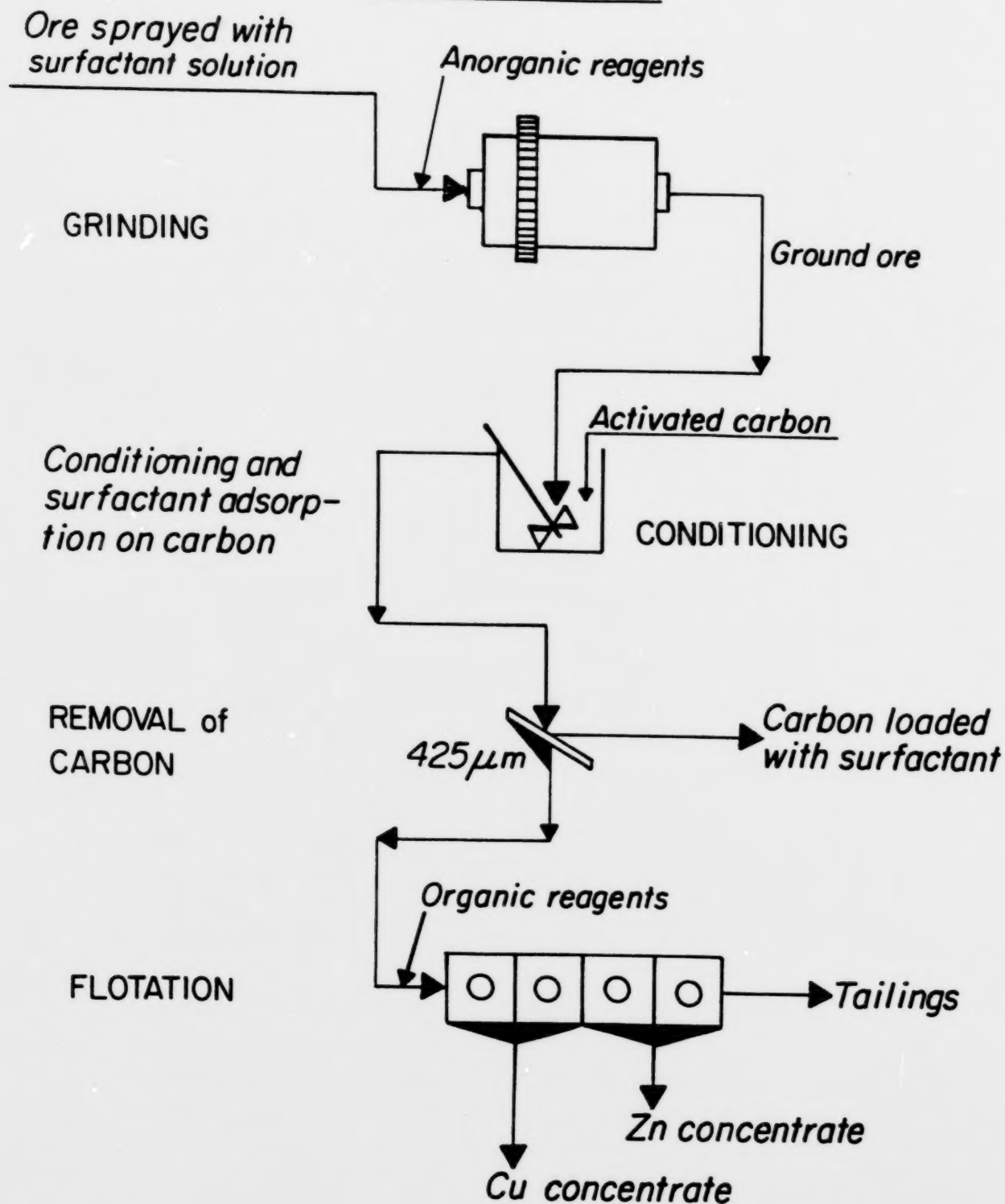
The best results were obtained under a carbon addition of 20-60 kg/tonne of ore. The carbon loss, by attrition, abrasion, etc., for these tests was less than 1 kg/t of ore.

The required carbon addition and consumption will depend on the amount of surfactant used to suppress dust. This could only be determined following experiments to suppress dust in an underground mine.

REFERENCES

1. Cristovici, M.A. and Lachapelle, P. "Investigation to select suitable wetting agents as sulphide ore dust suppressants and to study their influence on flotation results; Division Report MRP/MSL 83-66 (IR); CANMET, Energy, Mines and Resources Canada; 1983.
2. Cristovici, M.A. and Gilmour, T. "Investigation to eliminate the detrimental effect of dust-suppressing-wetting agents on flotation results (Opemiska copper ore); Division Report MRP/MSL 88-65 (IR); CANMET, Energy, Mines and Resources Canada; 1986.

Figure 1. SURFACTANT ADSORPTION AND REMOVAL
KIDD CREEK ORE



APPENDIX 1 - COST ESTIMATE PREPARED BY O.T.T.



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MEMORANDUM

NOTE DE SERVICE

TO  Marius Cristovici
MMS/ODS/MPL/CANMET

FROM F.J. Kelly
DE Project Analyst
OTT/CANMET

SECURITY - CLASSIFICATION - DE SÉCURITÉ

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Dust Supressent Removal

YOUR FILE — V / RÉFÉRENCE

DATE March 31, 1988

SUBJECT
OBJET

CAPITAL AND OPERATING COST ESTIMATES FOR A PROCESS TO REMOVE DUST SUPPRESSANT RESIDUE (DSR) FROM MILLED ORE PRIOR TO FLOTATION

Capital and operating cost estimates for the DSR process are based on the simplified flowsheet, Figure 1, developed by OTT staff from technology development data supplied by MSL. Missing from this flowsheet is a storage tank to hold one day's supply of mixed suppressant solution, wetting reagent metering pump, water pump and in-line mixer to feed the tank. The addition rate of the Alchem BA04 wetting reagent is 0.2 kg per tonne of ore.

A description of the DSR process based on the flowsheet shown in figure 1 is as follows. Cyclone overflow pulp, 30% solids by weight, solids density 3.3, is fed to one of two agitated conditioning tanks. Contact time in the conditioner is 15 minutes and is the time required for the contained carbon to absorb all of the organic dust suppressant residue brought in with the milled ore. Also feeding into this tank is +35 mesh carbon at the rate of 0.02 tonnes per tonne of contained ore from the carbon-in-pulp separation screen. The carbon free pulp flowing from this screen is sent to the flotation circuit. The hydrostall pump sends the slurry of carbon and pulp from the conditioner to the separation screen. At the end of 2.5 hours, equivalent to 10 charges of pulp in the conditioner, the carbon being fully laden with organic material is removed from the on-line conditioner circuit and sent to the regeneration system. At this time the cyclone overflow slurry commences feeding into the off-line conditioner. When this occurs the screw feeder also starts feeding regenerated carbon into this conditioner. The carbon, which is stored in water, is dewatered by the screw feeder at the same time. After 15 minutes of elapsed time the on-line conditioner is pumped empty and feed to the hydrostall pump is switched to the off-line conditioner, placing it on-line and taking the former off-line. At this time the screw feeder stops feeding regenerated carbon and the recirculated carbon flowing from the separation screen is diverted to the on-line conditioner. This cycle repeats itself every 2.5 hours without interrupting the flow of pulp to the flotation circuit.

In the carbon regeneration system the +35 mesh carbon is washed free of pulp and pumped to the loaded carbon hold tank. From the hold tank the loaded carbon is fed by the dewatering screw feeder to the indirect fired regeneration kiln. After a passage of 30 minutes at 670°C through the kiln the regenerated carbon discharges into a quench tank along with make-up fresh carbon and cooling water.

The carbon slurry is pumped from the quench tank to a carbon wash screen. The +20 mesh carbon from this screen is stored in a water filled hold tank and the -20 mesh fraction is sent to tails.

The DSR process was designed to treat 5,000 tonnes of milled ore per day. Material and energy balances were made around the flowsheet shown in Figure 1. Wherever possible CANMET's CANEVA system was used to size and cost the process equipment shown in Figure 1. Other pieces of equipment not covered by the CANEVA system were hand designed. Costs for these items were taken from in-house data or from quotations obtained from equipment suppliers.

Capital cost estimates for the DSR process are shown in Table 1. These costs are for an addition to an existing plant. Hence, the cost of buildings, utilities, facilities and other existing services are not included. The fixed capital cost was determined by applying factors derived from in-house data to the total delivered equipment cost for the process. The expected accuracy of the capital cost estimate is $\pm 30\%$. A detailed equipment list can be supplied upon request.

The operating cost estimate for the DSR process is given in Table 2. The basis for the estimate is as follows; mechanical availability 96% or 350 days per year. The plant operates three shifts per day seven days per week with a mill feed rate of 5,000 tonnes of ore per day. The operators salary shown in Table 2 contains a base wage of \$30,000/y plus 15%, 23%, and 12% of the base wage for supervision, labour burden and plant overhead respectively. Annual plant maintenance is estimated at 4% of fixed capital cost and of this figure 50% is for basic labour plus supervision and the remainder for replacement parts. Operating supplies are estimated to cost 20% of total maintenance. The basic wage for maintenance labour is \$32,000/y plus 20% for supervision with labour burden and plant overhead factors as above for operating labour yielding a wage of \$49,600/y.

The estimated installed fixed capital cost of the DSR process from Table 1 is \$2,004,600 say \$2,000,000. Four items of equipment account for 78% of this cost; carbon from pulp separation screens 11%, conditioners 26% and the carbon regeneration kiln 41%. The estimated operating cost, Table 2, for the DSR process is \$1.42 per tonne of ore processed. Of this total plant operation accounts for 11%, utilities 8%, reagents 70% and the plant capital charge 11%. Reagent usage will govern the cost of operating the this process.

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OTT

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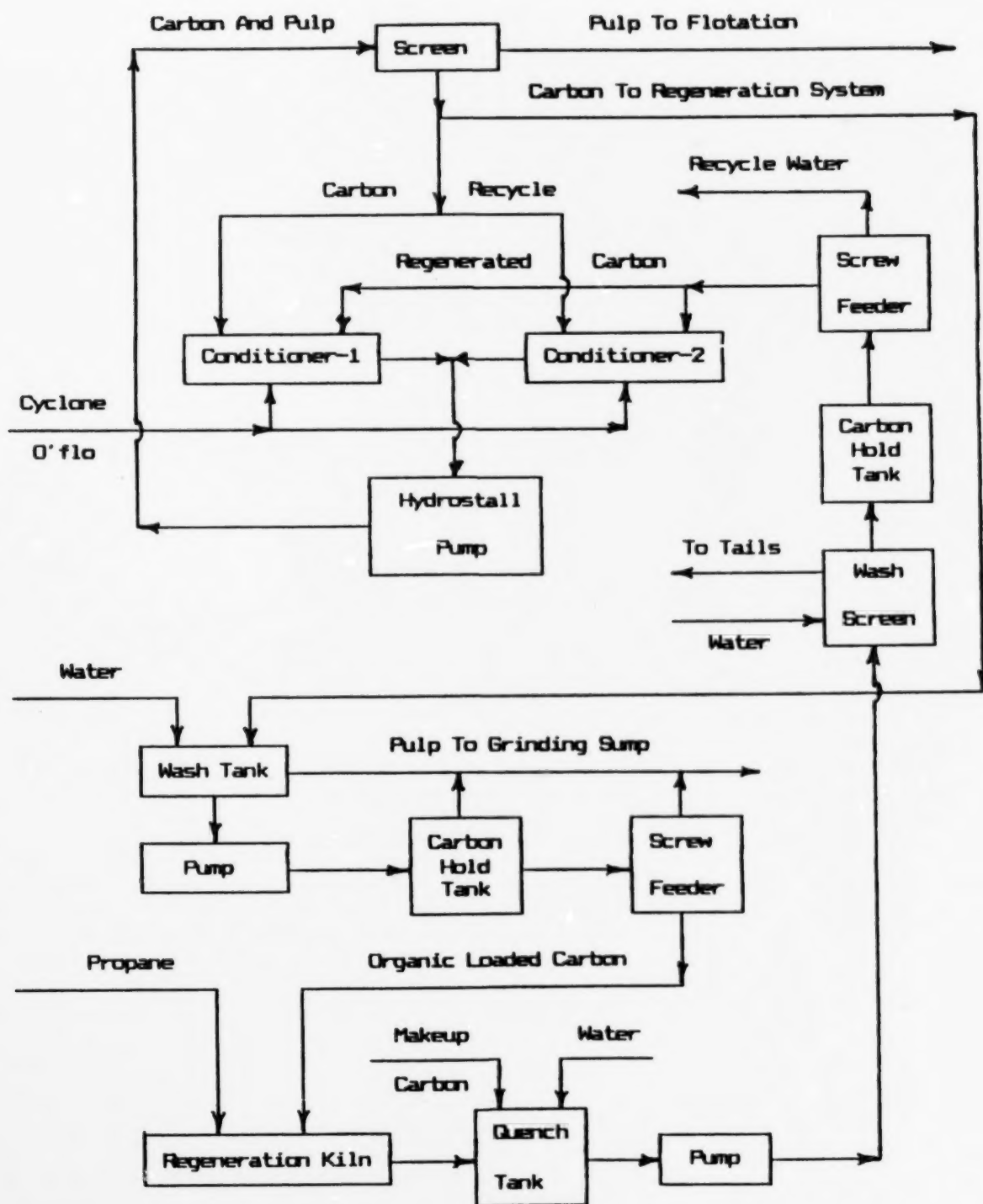


Figure 1 Dust Suppressant Residue Removal Flowsheet

Table 1 REMOVAL OF DUST SUPPRESSANT RESIDUE FROM MILLED ORE
PROCESS CAPITAL COST ESTIMATE, MARCH 1988 DOLLARS

ITEM	CANADIAN \$
Delivered equipment	689,600
Installation	175,800
Equipment foundations	75,900
Support structures	69,000
Piping	176,500
Electrical	77,200
Instrumentation	72,400
Total direct	1,336,400
Engineering	106,900
Management	93,600
Construction expenses	133,600
Total direct plus indirect	1,670,500
Contractor's fee	83,500
Contingency	250,600
Fixed capital cost	2,004,600

TABLE 2 REMOVAL OF DUST SUPPRESSANT RESIDUE FROM MILLED ORE
PROCESS OPERATING COST ESTIMATE, MARCH 1988 DOLLARS

ITEM	CANADIAN (\$/y)	ORE (\$/t)
Plant Operation		
Operating labour 4.00 @ \$45,000	180,000	0.10
Maintenance labour 1.04 @ \$49,600	51,500	0.03
Spare parts	40,100	0.02
Operating supplies	16,000	0.01
Total operation	287,600	0.16
Utilities		
Electric power @ \$0.046/kwh	47,600	0.03
Propane liquid @ \$86.00/m ³	143,600	0.08
Total utility	191,200	0.11
Reagents		
Alchem BA04 @ \$3000/t of reagent	1,050,000	0.60
Carbon @ \$2000/t of reagent	700,000	0.40
Total reagent	1,750,000	1.00
Capital charge 15 years @ 10% interest	263,600	0.15
Total annual cost	2,492,400	1.42